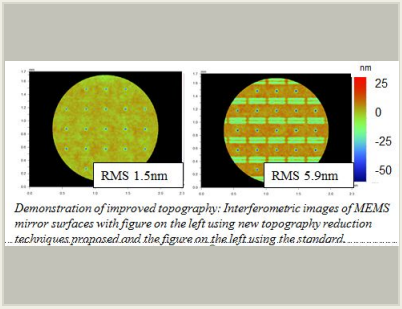
Small Business Innovation Research/Small Business Tech Transfer

Topography Improvements in MEMS DMs for High-contrast, High-resolution Imaging, Phase II

Completed Technology Project (2012 - 2015)

Project Introduction

We propose to develop a 3064 actuator, continuous facesheet MEMS deformable mirror using a modified fabrication process that will eliminate mid-spatial frequency surface figure errors resulting from actuator "print-through" topography and stress-induced mirror scallop topography. These figure errors, which occur at spatial frequencies outside the DM control band, are the most significant technological development hurdle preventing the use of MEMS DMs in proximity glare suppression for astronomical coronagraphy. Such wavefront control devices fill a critical technology gap in NASA's vision for high-contrast, high-resolution space based imaging and spectroscopy instruments. Space-based telescopes have become indispensible in advancing the frontiers of astrophysics. Over the past decade NASA has pioneered coronagraphic instrument concepts and test beds to provide a foundation for exploring feasibility of new approaches to high-contrast imaging. From this work, NASA has identified a current technology need for compact, ultra-precise, multi-thousand actuator DM devices. Boston Micromachines Corporation has developed MEMS DMs that represents the state-of-the-art for scalable, small-stroke high-precision wavefront control. The emerging class of high-resolution DMs pioneered by the project team has already been shown to be compact, low-power, precise, and repeatable. These DMs can be currently produced with uncorrectable shape errors as small as 10nm root mean square (rms). The residual shape errors on the DM are mostly periodic and act essentially as a grating, producing diffraction spikes in the image plane. In the Phase I effort, DM fabrication process modifications were developed which will enable the manufacture of these enabling components with an unprecedented surface figure of less than 2nm rms by eliminating surface features resulting from print-through , etch access holes, and mirror attachment posts, and compensating for residual stress induced scalloping.



Topography improvements in MEMS DMs for high-contrast, high-resolution imaging Project Image

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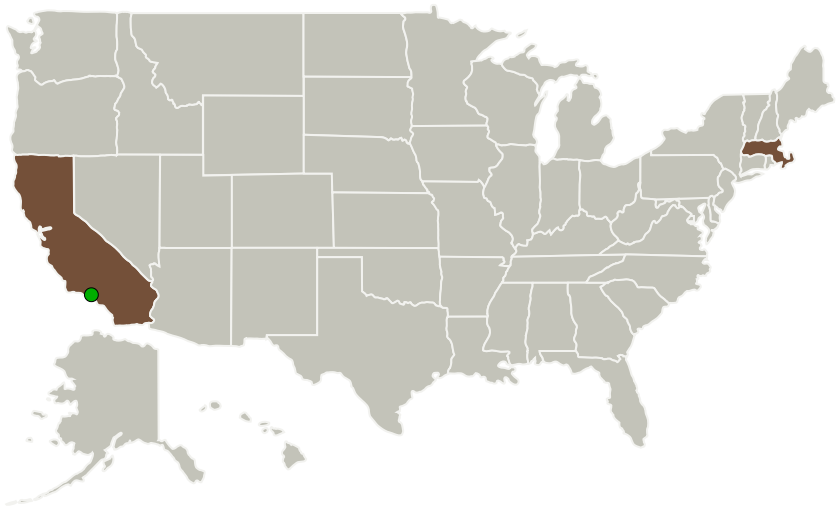
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Boston Micromachines Corporation	Lead Organization	Industry	Cambridge, Massachusetts
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Massachusetts

Project Transitions

December 2012: Project Start

March 2015: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140679)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Boston Micromachines Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

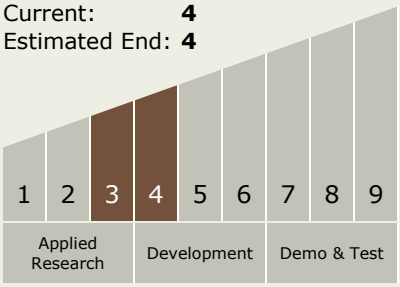
Carlos Torrez

Principal Investigator:

Steven A Cornelissen

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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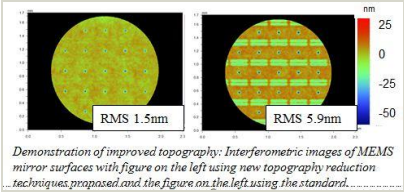
Images



Demonstration of improved topography: Interferometric images of MEMS mirror surfaces with figure on the left using new topography reduction techniques proposed and the figure on the left using the standard.

Project Image
Topography improvements in MEMS DMs for high-contrast, high-resolution imaging Project Image *(https://techport.nasa.gov/image/133816)*

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.3 Optical Components

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System